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Chapter 27. Watershed Management

Watershed management is the process of creating and implementing plans, programs, projects, and activities to restore, sustain, and enhance watershed functions. These functions provide the goods, services and values desired by the human community that is affected by conditions within a watershed boundary. In California, the practice of community-based watershed management, which is practiced in hundreds of watersheds throughout the state, has evolved as an effective approach to natural resource management. These community-based efforts are carried out with the active support, assistance, and participation of numerous State agencies and programs.

Using watersheds as an organizing unit has proven to be an appropriate landscape unit for the coordination and integrated management of the numerous physical, chemical, and biological processes that make up a river basin ecosystem (Box 27-1). It serves well as a common reference unit for the many different policies, actions, and processes that affect the system, and also provides a basis for greater integration and collaboration among those policies and actions.

PLACEHOLDER Box 27-1 Watershed Defined

[Any draft tables, figures, and boxes that accompany this text for the advisory committee draft are included at the end of the chapter.]

Watershed Management in California

A primary objective of watershed management is to increase and sustain a watershed's ability to provide for the diverse needs of the communities that depend on it, including local, regional, State and Federal stakeholders. Significant efforts to better manage natural resources using a watershed approach are occurring in several hundred structured efforts in all regions of California, involving organizations, local governments, landowners/users, and stewardship groups along with State and federal agencies.

Many of these efforts are working to blend community goals and interests with the broader goals of the state as a whole in a manner consistent with environmental, social, institutional, and economic conditions in the watershed. Emphasis at the community level has brought about a broader understanding of compatible and shared interests and has created innovative management approaches to meet these diverse interests. The need to address environmental justice and social equity has been recognized and addressed effectively, along with more traditional project management approaches.

In many communities, these organized efforts serve as forums to bring about collaborative management involving the public and private sector, the academic community, and people working at the local, regional, State, and national level, all benefitting from the inherent capabilities of each group. The benefits of watershed-based management are being realized in such diverse locations as the upper Feather River, the Los Angeles River Basin, and the Napa River, to name a few.

In addition to these local efforts, a number of regional, statewide, and national initiatives have been and continue to be carried out to help improve our overall ability to practice watershed management. A chronology of some notable initiatives in California follows.

State Watershed Management Chronology — Key Dates

1997 — *Ten Lessons Learned*. A summary of key experiences implementing the watershed management efforts from the US Environmental Protection Agency Office of Wetlands, Oceans and Watersheds (OWOW). The EPA initiative that prompted the State to begin addressing resource management from a watershed perspective.

1998 — Draft CALFED Watershed Strategy. Assembled by State and Federal agency representatives to respond to public comment regarding early expenditures by CALFED that largely left out projects above major dams or below Carquinez Strait. This evolved to the development of the CALFED Watershed Program as part of the overall CALFED Bay-Delta Program.

1997-99 — Watershed Protection and Restoration Council (WPRC). Established by Governor's executive order to develop statewide watershed management policies, focused largely on salmonid species recovery in California, that would foster and support community-based watershed management activities and coordination among State agencies.

1999 — Watershed Management Council (WMC) Forums. A series of public meetings to generate recommendations for improving coordination between the State and Federal governments, among State agencies, and between local management programs and State or Federal agencies. Created the *12 Steps to Watershed Recovery* document.

1999 — California Biodiversity Council Watershed Work Group (CBC-WWG). Formed to carry on the work begun by the WPRC and to develop principles and guidelines for coordinating State agency activities related to watershed management. Developed a set of management principles for watershed management activities and programs.

1998-2000 — CALFED Watershed Program. Established to aid in achieving the overarching goals of the CALFED Bay-Delta Program by working with communities at a watershed level. The Program Plan, published in 2000, was developed by a partnership of the Bay-Delta Advisory Committee's (BDAC) Watershed Work Group, the Inter-Agency Advisory Team (IWAT), and the CBC-WWG.

2000 — California Coastal Salmon and Watersheds program. Established to "recover harvestable salmon and steelhead populations, restore watersheds, and so contribute to building healthy communities."

2000 — California Watershed Network (CWN). A nonprofit organization with the mission to help people protect and restore the natural environments of California watersheds while ensuring healthy and sustainable communities. CWN worked to develop a coordinated network of community-based watershed management in California.

2000 — AB 2117 (Wayne). Established to evaluate a sample of locally-led watershed management partnerships and produce a report to the Legislature.

2001 — Joint Task Force on California Watershed Management. Established to oversee the report required by AB 2117. *Addressing the Need to Protect California's Watersheds*, published in 2002, lists the results of the investigation and makes recommendations to State government, one of which is to develop a watershed management strategic plan for the State.

2001 — Memorandum of Understanding between State and Federal government agencies to provide a framework for implementing the CALFED Watershed Program. The MOU, which expired in 2003, identified implementing and coordinating agencies, outlined their roles, and established a formal means of conducting the business of the CALFED Watershed Program element.

2002 — Watershed, Clean Beaches and Water Quality Act (Pavley). Authorizes the establishment of an Integrated Watershed Management Program to develop coordinated and complementary strategies and solutions for watershed management across landownership and agency jurisdictional boundaries.

2003 — Memorandum of Understanding between the Natural Resources Agency and California Environmental Protection Agency (Cal/EPA) to implement the Integrated Watershed Management Program from the Pavley bill. Established the California Watershed Council as an advisory group.

2003 — California Watershed Council. Designed to provide advice and recommendations to agency secretaries regarding watershed management policy and programs. The group generated several work products that included a set of basic principles, and a series of recommendations for funding processes, technical assistance, communications, information sharing, and coordination processes.

2003 — AB 1405 (Wolk) California Watershed Protection and Restoration Act. Enacted the California Watershed Protection and Restoration Act to encourage Cal/EPA and the Natural Resources Agency to provide assistance and grants to those who choose to participate in watershed restoration and enhancements, and declared that local collaborative watershed partnerships are in the State's interest in terms of effectiveness, citizen involvement and community responsibility. This bill authorizes certain State agencies to provide technical assistance to local watershed partnerships, and requires that State guidelines adopted for use by local watershed partnerships provide flexible mechanisms to achieve quantifiable watershed objectives.

2003 — California Agency Watershed Program Strategic Plan. Developed by a consultant group after interactions with members of the Joint Task Force on California Watershed Management.

2004 — Memorandum of Understanding (revised) between Cal/EPA and the Natural Resources Agency. The revisions to the 2003 MOU were designed to emphasize and implement the Governor's Environmental Action Plan and the Ocean Action Plan, using stakeholder advisory processes and inter-agency collaboration

2005 — California State Agency Watershed Management 18-month Action Plan. Designed to replace the Strategic Plan with a more action-oriented approach for agencies to pursue watershed management.

2007 — Statewide Watershed Program. The Secretary for Natural Resources called for the transition of the CALFED Watershed Program to a Statewide Watershed Program and assigns the Department of Conservation to administer it.

Bond measures have brought significant funding for the maintenance and restoration work that is needed in many of the state's watersheds. Recent bond measures (Propositions 50 and 84) stressed the need for integrated planning that includes objectives at the watershed and regional scales, and provide incentives to carry out work consistent with these plans.

Potential Benefits of Watershed Management

Managing our interactions with and impacts on natural ecosystems produce a number of significant benefits when done with a watershed approach that emphasizes maintaining, restoring, or enhancing the many functions associated with these natural systems. Many of these benefits, such as reliable quantities of clean water, agricultural or forest products, and biofuels, and avoided costs such as reduced flood or fire damages can are described using traditional economic terms such as a products, goods, or services and are readily quantified and valued in the traditional marketplace. Other values associated with natural systems such as biological diversity, disease suppression, and climate moderation are more difficult to quantify monetarily because these values are not routinely traded in the marketplace. As a result, the term "ecosystem services" is often used to better describe and equate the monetary and non-monetary values or benefits provided to society by healthy watersheds. Some typical watershed products, goods and services are given in Table 27-1.

PLACEHOLDER Table 27-1 Typical List of Watershed Products, Goods and Services

[Any draft tables, figures, and boxes that accompany this text for the advisory committee draft are included at the end of this chapter.]

Potential Costs of Watershed Management

Costs associated with watershed management depend on many factors, such as the size of the watershed; the land and water use activities occurring in the watershed; the condition and trends of the watershed; and the values, goods, and services demanded from the watershed. Much of the cost of watershed management in California is associated with the specific land or water use activities occurring within the watershed on a recurring basis and is directly related to these uses. The additional or external costs of watershed management that are discussed in this chapter tend to be associated with interventions designed to influence management or improve the results of management, to offer specific protection for certain functions and values, or to restore the functional conditions and associated uses of a watershed. These interventions may come from various levels of government or interests either within or outside the watershed. The potential costs associated with these interventions are estimated here by:

- Extrapolating costs based on other program expenditures (See Table 27-2, which was also used in California Water Plan Update 2005, Volume 2 Resource Management Strategies, Chapter 25 Watershed Management. Estimates are based on CALFED watershed management estimates scaled up for statewide coverage.)
- Applying a "willingness to pay" approach based on existing examples (using CALFED Watershed Program analysis as part of Program Finance Plan development)

In addition to the more easily quantified benefits of well-functioning watersheds, effective watershed management can also result in significant avoided costs such as lessened fire and flood damage, erosion and sediment loss reduction, water quality maintenance, reduced illnesses and treatment costs, and control of agricultural pests. An example is shown in Box 27-2 Watershed Degradation and Water Treatment Costs.

PLACEHOLDER Table 27-2 Estimates of Watershed Management Costs to Year 2030, from Water Plan Update 2005 and CALFED Program Estimates

[Any draft tables, figures, and boxes that accompany this text for the advisory committee draft are included at the end of this chapter.]

PLACEHOLDER Box 27-2 Watershed Degradation and Water Treatment Costs

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Willingness to Pay

To estimate the approximate external costs to fully implement the watershed management strategy, an analysis developed by the CALFED Watershed Program is used, which examined areas where communities have chosen to provide quantifiable financial support for watershed management, thus demonstrating "a willingness to pay" for the services provided by a well managed watershed. This analysis, developed using methods described by the US Department of Energy (Natural Resource Valuation, 1997), and the US Congressional Research Service (RL30242 Report for Congress, 1999), is an attempt to assign a monetary value to effective watershed management.

Napa County was used as a basis for this comparison for several reasons. First is its demographic similarity to the demographic makeup of the state as a whole. Second, taxes are collected that are directly tied to implementation of community-generated watershed management plans; these tax levies also demonstrate strong local support among voters and elected officials for the values inherent in improved watershed management. Finally, these funds are generated and dispersed locally, by locally responsive government entities.

Valuations from three different Napa County tax measures were investigated: a half-cent sales tax passed by 68 percent of voters in the late 1990s that generates approximately $10 million in revenue per year specifically for watershed management (the "Living River" program); a parcel tax of $12.70 per parcel that is supported and levied within the City of Napa for watershed management; and an additional parcel tax of $12 per year specifically for storm water runoff management inside the city's watersheds. These assessments generate funds that range from nearly $14,000 per square mile for the sales tax revenue, to just under $1,600 per square mile for the parcel tax. For the purposes of this value estimate, a lower amount of $1,572 per square mile area is used, which in turn is adjusted to account for the slight difference in demographic statistics between Napa and California at large. These value estimates (Table 27-3) represent the annual, external cost of fully implementing the watershed management strategy over approximately half the surface area of California, including all or part of the Sacramento River, San Joaquin River, Tulare Lake, San Francisco Bay, South Coast, and South Lahontan hydrologic regions.

PLACEHOLDER Table 27-3 Cost Estimate to Fully Implement the Strategy — Willingness to Pay

[Any draft tables, figures, and boxes that accompany this text for the advisory committee draft are included at the end of this chapter.]

Simple extrapolation of this value to the entire land area of the state would result in an estimated annual cost of $221 million to "fully implement" the strategy. For this example, fully implement suggests extensive application within the regions of the Policy Level and Strategic Practices recommendations in this chapter. It should be noted here that an as yet undetermined, but likely significant, portion of that cost is not an added cost, but existing expenditures applied differently. For instance, permits and stream alteration agreements issued by watershed boundary instead of jurisdictional boundary could result in considerable added benefit and positive effect without adding to the real cost of implementation. Also, land use planning done on the basis of watershed impact may yield higher beneficial results without increasing costs.

Major Issues Facing Watershed Management

Managing land and water resources for selected products, services, and values has altered the conditions and functions of many watersheds in California. These management activities have produced some negative effects that need to be addressed to continue to effectively manage and utilize watershed services.

Altered Hydrologic Cycles

The hydrologic cycle includes precipitation, the flow of water over and beneath the land, and the evaporation of water into the atmosphere. How land is managed can reduce rainwater infiltration and the timing and volume of runoff. Storms are increasingly characterized by high intensity runoff over short periods, especially in urban areas but also in some rural areas, which creates a risk of flooding and reduces the ability of the water supply infrastructure to capture water for use during dry times. This compression of runoffs robs the streams and landscape of groundwater, leading to dry land, a shift in vegetation types, lower and warmer streams, and deterioration of stream channels, all of which lead to shifts in the plants and wildlife that can be supported. In some areas, diversion of water from streams in the watershed to other regions outside the watershed, or the application of water imported from outside the watershed, has dramatically changed ecological functions or altered the flow of water through the watershed.

Altered Nutrient Cycles

As watersheds are developed, the amount of dissolved nutrients in streams within the watershed is increased, often deriving from fertilizers or biosolids. These increased concentrations of nutrients can trigger dramatic changes in water bodies, vegetation, and wildlife communities. Nutrients generated by human activity are frequently exported from the location that they are generated or applied by humans to a downstream or downslope water body, often from inappropriate use or excessive application rates, where they can support algae or other plant growth that impairs the usability and ecological quality of water bodies. In addition to direct effects on surface and ground waters, increased nutrients can lead to the establishment of non-native invasive plant species at the expense of native vegetation. Many native plants

evolved under relatively low nutrient conditions, and increased nutrient availability often creates conditions that favor non-native invasive plant species, which can outcompete the native vegetation and form stands of a single species with little or no biological diversity, little habitat value for wildlife, and altered soil conditions such as reduced infiltration capacity.

Life Cycles and Migration Patterns of Wildlife

Many projects built in the past, prior to modern environmental laws such as CEQA and NEPA, have disrupted wildlife migration corridors or destroyed or degraded habitat that is critical for certain animal life stages. Some examples of the effects of watershed alteration on wildlife ecology are found in the changes in freshwater inflows to coastal wetlands caused by changed watershed conditions, which directly affects many estuarine and ocean species that breed and rear in these communities; blocked access to spawning and rearing habitats for anadromous fish by the dams that impound water on most significant California waterways, and reduction in extent of the riparian forests that support migration of Pacific Flyway bird species.

Fire and Water

Active suppression of wildland fires since the 1920's has created an increased risk of very large, very intense wildfires that do much more damage to watersheds than fires of historical intensities. Modern watersheds have limited capabilities of rapidly recovering from these fires and accelerated soil erosion, diminished productivity and diversity of plant communities, displaced wildlife, significant alterations of natural biological cycles and limited subsequent human use of the lands are typical aftereffects. These catastrophic fires also have large effects on hydrology and water quality within a watershed, causing increased surface runoff and reduced infiltration, creating more frequent and severe downstream flood events, exacerbating water quality problems, increasing operations and maintenance costs for reservoirs and canal systems, and producing large economic losses to local communities.

Climate Change

Watershed integrity is vulnerable to the changes in temperature, precipitation, and water flows that are likely under currently predicted scenarios of climate change. As indicated in Box 27-1, each element of a watershed system must be considered in context with the others because changes in one element (e.g., the hydrologic cycle) spurs changes in the others (e.g., the role of flood and fire), creating a different system outcome. Watersheds within regions where precipitation decreases can become more susceptible to pests, fires, and pollutants. Predicted increases in storm intensity could increase inland and coastal flooding, increasing the likelihood of downstream property damage and loss of life, and runoff from high-intensity storms would cause increased rates of soil erosion and soil loss, particularly in watersheds recovering from recent droughts and fires because soils in those areas will lack vegetation cover that stabilizes soils.

Adaptation

As indicated in Table 27-1, a diverse watershed ecosystem can be resilient to changes in climate, therefore maintaining a healthy watershed ecosystems will be of critical importance in the face of a changing climate by ensuring that ecosystem functions within a watershed will continue to provide the

goods, services, and values of the systems we rely on today. How land is managed affects the way watersheds can adapt to the effects of climate change, and an effective watershed management strategy provides multiple benefits to human society, such as producing water, food, fiber, and fuel; mitigating floods and droughts, providing aquatic and terrestrial habitats and recreational opportunities, moderating local climate, and maintaining biodiversity and healthy soils. Managing our interactions with natural watershed systems to maintain, restore, and enhance the many functions within a watershed allows us to have reliable quantities of clean water, and agricultural and forest products. An effective watershed management strategy also helps to reduce the cost of flood and fire damages, suppress disease, and increase biodiversity.

Mitigation

California's forested watershed ecosystems have relatively high carbon sequestration potential, and appropriate vegetation management can significantly increase rates of carbon sequestration as well as reduce rates of natural carbon emissions. Improved watershed management for water reuse, pollution control, and other ecosystem services could provide multiple opportunities to reduce the energy use and emissions of greenhouse gases. Tracking and reporting changes in California's major watersheds could help to assess and evaluate water quality and watershed conditions for controlling pollution and saving related energy.

Supporting adaptive management programs could provide opportunities to control energy use and greenhouse gas emissions by a) avoiding negative impacts on ecological conditions, water quality and watershed functions, and b) adjusting the operations or re-designing existing projects to create benefits for climate change mitigation. Providing technical information and watershed education and outreach in the decision-making process could have long-term benefits for climate change mitigation related to the maintenance and improvement of watershed functions, water conservation, water re-use, and water pollution prevention.

Other opportunities within this strategy to mitigate for energy use and greenhouse gas emissions include management actions to maintain and improve watershed function, including a) designing and selecting projects to avoid negative impacts on ecological conditions, water quality and watershed functions, and b) controlling storm water, reducing surface runoff, and retaining intact floodplains and wetlands to maintain and improve watershed function and control water pollution.

Water use efficiency practices in watersheds could have benefits for reducing energy use and greenhouse gas emissions, including a) decreasing the amount of irrigated landscaping in the watershed and increasing the use of native vegetation in landscaping and agricultural buffer lands, and b) installing and maintaining stream flow gauges to measure water use. Improving watershed ecosystem functions by restoring and preserving stream channel morphology and creating habitats around stream and river corridors could provide carbon sequestration potential for greenhouse gas reduction. However, energy use efficiency and clean energy standards should be used to offset related greenhouse gas emissions during restoration.

Recommendations for Improved Watershed Management in California

Policy Level Recommendations

1. Establish a scientifically valid means of tracking and reporting changes in the state's major watersheds that provide reliable, current information to local communities, State and Federal agencies and others regarding the net effects of management against the background of external change.
2. Support adaptive management programs that regularly assess the performance and condition of projects and programs to determine if they are satisfying ecological and community needs compatibly. Adjust the operations or re-design existing projects or programs as needed.
3. Clearly define expected products, goods and services at the State level, to provide a large-scale basis from which to apply local variations and additions.
4. As appropriate and feasible, coordinate State funding and support within watersheds and between programs to generate more focused, measurable results.
5. More effectively align agency goals and methods to reflect coordinated approaches to resource management using watersheds as the unit of implementation and effectiveness measurement.
6. Provide easy access to technical information such as geographic information system (GIS) layers, monitoring data, planning models and templates, and assessment techniques from multiple sources, which are useful at multiple levels of decision-making.
7. Conduct management activities in a manner, and within a context, that is consistent with watershed dynamics and characteristics.
8. Provide local land-use decision-makers with watershed education and information access to promote maintenance and improvement of watershed functions in local decision-making.

Strategic Practices Recommendations:

9. Use a watershed approach to coordinate forest management, land use, agricultural land stewardship, integrated resources planning and other appropriate resource strategies and actions.
10. Design and select projects with ecological processes in mind and with a goal of making the projects as representative of the local ecology as possible.
11. Increase precipitation infiltration into the soil to reduce surface runoff to a level that is typical of natural runoff retention patterns; this goal is often achieved by reducing impervious surfaces within a watershed. Retain intact floodplain and other wetlands to the extent possible, to maintain or increase residence time of water in the watershed.
12. Decrease the amount of irrigated landscaping in the watershed, and increase the use of native vegetation in landscaping and agricultural buffer lands.
13. Design appropriate wildlife migration corridors and biological diversity support patches within watersheds when planning fire-safe vegetation alteration.
14. Promote the installation and maintenance of stream flow gauges in major drainages.
15. Maintain and create habitat around stream and river corridors that is compatible with stream and river functions. Provide as much upslope compatibility with these corridors as possible.
16. Design drainage and storm water runoff controls to maximize infiltration into local aquifers, and minimize immediate downstream discharges during runoff.
17. Provide regionally appropriate, regular and dependable educational materials to encourage water conservation, water re-use, and water pollution prevention.

18. Restore and preserve stream channel morphology to provide flood waters access to the flood-plain and to encourage stable banks and channel form.
19. Restore the characteristics and functions of native grasslands, woodlands, forests and other wildlands.
20. Remove and/or control invasive weeds as a part of overall resource management efforts.
21. Protect soil resources and restore the functions of drastically disturbed soils, to slow run off and increase rainfall infiltration.
22. Proactively address the recovery of special-status species, at both watershed and population scales, and incorporate measures to avoid future listing of other at-risk species.

Watershed Management in the Water Plan

[This is a new heading for Update 2013. If necessary, this section will discuss the ways the resource management strategy is treated in this chapter, in the regional reports and in the sustainability indicators. If the three mentions aren't consistent, the reason for the conflict will be discussed (i.e., the regional reports are emphasizing a different aspect of the strategy). If the three mentions are consistent with each other (or if the strategy isn't discussed in the rest of Update 2013), there is no need for this section to appear.]

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